## CLAIMS

1. Process for melting and refining vitrifiable materials, ***characterized in that*** all or part of the thermal energy necessary for melting the said vitrifiable materials is supplied by the combustion of fuel(s) with at least one oxidizer gas, the said fuel(s)/gas or the gaseous products resulting from the combustion being injected below the level of the mass of vitrifiable materials (7) ***and in that*** the refining of the vitrifiable materials after melting takes place at least partly in the form of a "thin layer".

2. Process according to Claim 1, ***characterized in that*** the oxidizer is based on air, oxygen-enriched air or oxygen.

3. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the melting of the vitrifiable materials takes place in at least one melting chamber (2) which is equipped with burners (5) passing through its side walls and/or passing through the siege (4) and/or suspended from the roof (3) or from superstructures so that their combustion regions (6) or combustion gases develop in the mass of vitrifiable materials (7) being melted.

4. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the combustion regions (6) created by the combustion of fossil fuel with the oxidizer gas(es) and/or the gases resulting from the said combustion convectively stir the vitrifiable materials (7).

5. Process according to Claim 3 ~~or Claim 4~~, ***characterized in that*** the height of the mass of vitrifiable materials (7) in the melting chamber (2) and the height at which the combustion regions (6)/gases resulting from the combustion develop are adjusted so that the said fuels/combustion gases remain within the mass of the said vitrifiable materials.

6. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the melting is preceded by a step of preheating the vitrifiable materials to at most 900°C.

7. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the vitrifiable materials comprise batch materials and/or cullet and/or vitrifiable scrap and/or combustible elements, especially glass-plastic composites, glass-metal composites, organic materials, or coal.

8. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the refining operation is carried out on the molten vitrifiable materials of the glass type in the foamy state, having especially a density of approximately 0.5 to 2 $g/cm^3$.

9. Process according to Claim 8, ***characterized in that*** the refining is carried out on molten vitrifiable materials of the glass type in the foamy state, most of the bubbles being at least 100 or even at least 200 $\mu m$ in diameter.

10. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the vitrifiable materials contain refining promoters, especially reducing additives of the coke type, preferably having an average particle size of less than 200 $\mu m$, sulphates, or fluorine- or chlorine-based additives, or nitrates of the $NaNO_3$ type.

11. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the melting is carried out at 1400°C at most, especially 1380 or 1350°C at most, and the refining at 1500°C at most.

12. Process according to ~~one of the preceding~~ claims, ***characterized in that*** the refining is carried out in at least one static compartment lying downstream of the melting chamber (2), of the flow-canal type (9), and provided with one or more means for forcing the

molten vitrifiable materials to be refined in a thin layer, especially to a depth of at most 15 cm, preferably to at most 10 cm, with flow of the plug-flow type.

13. Process according to Claim 12, ***characterized in that*** the said one or more means prevent the formation of a return glass current in the mass of molten vitrifiable materials flowing through the said compartment(s) (9).

14. Process according to ~~one of~~ Claims 1 ~~to 11~~, ***characterized in that*** the refining is carried out in the actual melting chamber (2) or in at least one compartment lying downstream of the latter, forcing the molten vitrifiable materials to follow a descending path by gravity between at least two adjacent walls (53, 53') which are essentially mutually parallel and at least partially submerged in the mass of molten vitrifiable materials and are inclined with respect to the plane of the siege of the said melting chamber or of the said downstream compartment.

15. Process according to Claim 14, ***characterized in that*** the said walls are incorporated into at least one longitudinally partitioned tube (50) of approximately rectangular section.

16. Process according to ~~one of~~ Claims 1 ~~to 11~~, ***characterized in that*** the refining is carried out in at least one compartment (21) lying downstream of the melting chamber (2) and capable of being rotated in order to ensure centrifugal refining, which compartment is provided with one or more means for forcing the molten vitrifiable materials to be refined in a thin layer, over a "thickness" R1/R0 of at least 0.8 or over an absolute thickness of at most 10 cm.

17. Process according to ~~one of the preceding~~ claims, ***characterized in that*** all or some of the vitrifiable materials are introduced into the melting

chamber (2) below the level of the mass of vitrifiable materials being melted.

18. Apparatus for melting and refining vitrifiable materials, especially intended for implementing the process according to ~~one of the preceding~~ claims, ***characterized in that*** it comprises:

→ at least one melting chamber (2) equipped with burners (5) which are fed with fossil fuel(s) of the natural gas type and with oxidizer(s) of the air or oxygen type, the said burners being placed so as to inject the said fuels/gases or gases resulting from their combustion below the level of the mass (7) of vitrifiable materials introduced into the said melting chamber;

→ means for refining the molten vitrifiable materials in the form of a "thin layer", in the actual melting chamber (2) or in at least one refining compartment (9, 21) downstream of the said chamber.

19. Apparatus according to Claim 18, ***characterized in that*** the refining compartment(s) (9) is(are) static and has(have) a flow canal comprising a channel (10) and a roof (11), the one or more means of forcing the molten vitrifiable materials to be refined in the said canal in a thin layer, with flow of the plug-flow type, especially over a depth of less than 15 cm, being at least the selection of the ratio of the average height to the average width of the said canal, this ratio being less than 1 and especially less than 0.5.

20. Apparatus according to Claim 18 ~~or 19~~, ***characterized in that*** the refining compartment(s) is(are) static and has(have) a flow canal comprising a channel (10) and a roof (11), the one or more means for forcing the molten vitrifiable materials to be refined in the said canal in a thin layer, especially over a depth of less than 15 cm, being at least one or more means for adjusting/regulating the flow of the molten

vitrifiable materials at the inlet and/or at the outlet of the refining compartment (9).

21. Apparatus according to ~~one of~~ Claims 18 ~~to 20~~, ***characterized in that*** the flow canal (9) is equipped with heating means, especially of the type having oxygen burners (13), above the molten vitrifiable materials.

22. Apparatus according to ~~one of~~ Claims 18 ~~to 21~~, ***characterized in that*** the flow canal is provided with means for homogenizing the vitrifiable materials.

23. Apparatus according to Claim 18, ***characterized in that*** the melting chamber (2), or a refining compartment downstream of the latter, comprises at least one structural means for thin-film refining, in the form of at least two adjacent walls (53, 53') which are approximately mutually parallel, intended to be at least partially submerged in the mass of molten vitrifiable materials and inclined with respect to the siege of the said chamber or of the said compartment.

24. Apparatus according to Claim 23, ***characterized in that*** these walls are incorporated into at least one longitudinally partitioned tubular element (50), especially having an approximately rectangular section.

25. Apparatus according to Claim 24, ***characterized in that*** this or these tubular element(s) (50) (is) are in the melting chamber (2) and emerge(s) in the discharge opening (8) downstream of the said chamber.

26. Apparatus according to Claim 18, ***characterized in that*** the refining compartment includes at least one device (21) capable of being rotated in order to ensure centrifugal refining, the internal walls (33) of the said device defining approximately a cavity in the form of a hollow cylinder which is vertical in its central part.

27. Apparatus according to Claim 26, ***characterized in that*** the device (21) capable of being rotated is

provided in the cavity with partitions (34), over at least part of its height, forcing the molten vitrifiable materials to flow between the internal walls (33) of the device and the said partitions (34), the average distance between the walls and the partitions defining the "thickness" of the thin layer.

28. Apparatus according to Claim 27, ***characterized in that*** the average distance between the walls and the partitions is defined by a ratio of their radii R1/R0 of at least 0.8.

29. Apparatus according to one of Claims 26 to 28, ***characterized in that*** the walls of the device are lined with refractory pieces (32) of the electrocast type, these including a thermal insulator (31) incorporated so as to avoid being crushed by the centrifugal force.

30. Apparatus according to ~~one of~~ Claims 26 ~~to 29~~, ***characterized in that*** the device (21) is provided with one or more means for trapping solid particles, these being especially located in its lower zone (23) and being in the form of notches/grooves (28) made in its internal walls (33).

31. Apparatus according to ~~one of~~ Claims 18 ~~to 30~~, characterized in that the melting chamber (2) is equipped with at least one means of introducing vitrifiable materials below the level of the mass of vitrifiable materials being melted, especially at least two of them, preferably in the form of one or more openings associated with a supply means of the feed-screw type.

32. Apparatus according to ~~one of~~ Claims 18 ~~to 31~~, ***characterized in that*** the walls of the melting chamber (2), especially those intended to be in contact with the mass of vitrifiable materials being melted, are based on refractory materials associated with a cooling system using a fluid of the water type.

33. Apparatus according to ~~one of~~ Claims 18 ~~to 32~~,

***characterized in that*** the walls of the melting chamber (2), especially those intended to be in contact with the mass of vitrifiable materials being melted, are based on refractory materials lined with a lining of metal (40) of the molybdenum type.

34. Apparatus according to Claim 33, ***characterized in that*** the said lining (40) is held at some distance from the walls consisting of the refractory materials.

35. Apparatus according to Claim 33 ~~or 34~~, ***characterized in that*** the said lining constitutes a surface for contact with the molten materials which is continuous or drilled with holes (41).

36. Apparatus according to ~~one of~~ Claims 18 ~~to 35~~, ***characterized in that*** at least some of the burners (5) of the melting chamber (2) are designed to also be able to inject, into the mass of vitrifiable materials, a fluid which does not participate in the combustion, as a substitute for the oxidizer and/or the fuel, especially an inert gas of the $N_2$ type and/or a coolant of the water type.

37. Application of the process according to ~~one of~~ Claims ~~1 to~~ 18 ~~or of the apparatus according to one of Claims 19 to 36~~, to the manufacture of flat glass, especially flat glass having a residual blue colour and a solar-protection or fire-resistance function, for the electronics industry, to the manufacture of glass hollow-ware of the bottle or flask type, or to the manufacture of glass wool or of glass fibre for reinforcement.

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